

BOGUE CHITTO NATIONAL WILDLIFE REFUGE
BASELINE CONTAMINANTS SURVEY
1991

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ABSTRACT

Bogue Chitto National Wildlife Refuge (NWR) is located along the Pearl River in Louisiana and Mississippi, and includes some 37,028 acres of mixed bottomland hardwoods and cypress-tupelo swamps. These forested wetlands are highly productive habitat for fish and wildlife resources, and provide excellent outdoor recreational opportunities.

The NWR and surrounding area provide habitat for a variety of mammals, birds, reptiles, amphibians, and fishes. The area also serves as a breeding, wintering, and resting area for migratory birds. The NWR is within the range of several Federally listed endangered or threatened species.

The water quality of the Pearl River and its backwaters is subject to potential impacts from agricultural, municipal, industrial, and hazardous waste site discharges. During 1991, fishes and sediments were collected from the NWR and subsequently analyzed for organochlorine pesticides, polychlorinated biphenyls (PCBs), aliphatic hydrocarbons, and heavy metals. Sediment samples were also analyzed for polycyclic aromatic hydrocarbons.

DDE was detected in only one fish; all other organochlorines were below detection limits. PCB levels were elevated in fishes of both the northern end of the refuge and the area just south of the NWR boundary. Inorganic contaminant concentrations in fish were, for the most part, unremarkable. However, concentrations of four heavy metals were elevated, with mercury levels warranting the most concern. Xenobiotics in sediments were within currently acceptable levels at all locations sampled.

KEYWORDS: National Wildlife Refuge, organochlorine pesticides, DDE, PCBs, aliphatic and polycyclic aromatic hydrocarbons, heavy metals, fish, and sediment.

INTRODUCTION

Bogue Chitto National Wildlife Refuge (NWR) was established in 1980 by Public Law 96-288, which authorized acquisition of 40,000 acres in the lower Pearl River Basin. The NWR is located approximately 30 miles northwest of New Orleans, along the Pearl River (the Louisiana-Mississippi border) in Washington and St. Tammany Parishes, Louisiana, and Pearl River County, Mississippi. In 1989, Congress authorized a boundary expansion for the NWR that included an additional 8,400 acres in St. Tammany Parish. To date, some 37,028 acres have been placed under management.

The NWR was established to preserve and enhance a unique ecosystem composed of mixed bottomland hardwoods (oaks, hickories, American elm, sweetgum, sycamore, and black willow) and cypress-tupelo brakes. The importance of these forested wetlands lies in their high habitat value for fish and wildlife, their role as a natural floodway, and the opportunities that they provide for high-quality outdoor recreation.

A total of 150 bird species (i.e., transients or permanent residents) use the NWR for resting, breeding, and wintering. More than 40 mammalian species occur on the NWR, including white-tailed deer, river otter, bobcat, and gray squirrel. At least 131 species of reptiles and amphibians and 140 fish species have been observed on the NWR. The NWR is within the range of several Federally listed endangered or threatened species. The gopher tortoise, ringed-sawback turtle, Gulf of Mexico sturgeon, and possibly the Louisiana black bear are also known to occur on the NWR.

The water quality of the Pearl River and its backwaters are subject to potential impacts from agriculture, a chemical plant, a pulp mill, a creosote plant, and other urban and industrial discharges. During 1991, fishes and sediments were collected and subsequently analyzed for organochlorine pesticides, polychlorinated biphenyls (PCBs), aliphatic hydrocarbons (APHs), and heavy metals. Sediments were also analyzed for polycyclic aromatic hydrocarbons (PAHs).

The current study was conducted to provide baseline data on potential threats from exposure of the NWR's resources to the above contaminants. Study objectives included assessment of the potential detrimental effects to the NWR's fish and wildlife resources; assessment of potential human health hazards from consumption of fish and wildlife taken on the NWR; identification and distribution of contaminants on and off NWR lands; and to provide recommendations on potential means to reduce fish and wildlife resource exposure to various sources of contamination.

METHODS AND MATERIALS

Sampling was conducted on July 9 and 10, 1991. Fishes were collected with a boat-mounted electroshocking apparatus, and sediment samples were taken with a petite ponar dredge. Sampling stations are presented in Figures 1 and 2, and are listed as Stations 1 through 6 (from south to north) in Table 1. Sediment samples were obtained from all six locations; however, no fish were collected from Station 3.

Table 1. Station numbers and locations for sediment and fish samples collected from Bogue Chitto NWR and adjacent waters in July 1991

STATION	DATE COLLECTED	LOCATION	TOWNSHIP/RANGE
1	7/9/91	NASA Access Channel	T7S, R16E, Sect. 18
2	7/9/91	Mills Creek	T6S, R15E, Sect. 38
3*	7/9/91	Hobolochitto Creek	T6S, R15E, Sect. 18
4	7/10/91	Talisheek Creek	T6S, R13E, Sect. 12
5	7/10/91	Bogue Chitto River	T5S, R15E, Sect. 32
6	7/10/91	Pools Bluff	T4S, R13E, Sect. 40

* No fishes collected

A total of 22 fishes were collected, 16 of which were analyzed as individual whole-body samples. The 6 spotted suckers collected were analyzed as 2 composite samples (i.e., three fish/composite). Upon collection, samples were placed on ice. They were maintained on ice until that evening, at which time they were weighed, measured, wrapped in foil, labeled, and placed in frozen storage.

Three sediment grabs were collected at each station with an analytically clean, stainless steel, petite ponar dredge. The samples were subsequently homogenized in a stainless steel bowl, and the homogenate was placed in a labeled, analytically clean, glass jar capped with a teflon-lined lid. Sediment samples were held on ice for weighing and placement in frozen storage later that day.

The analytical methodologies for the organochlorine pesticides, APHs, PAHs, and heavy metals are detailed in Appendix A.

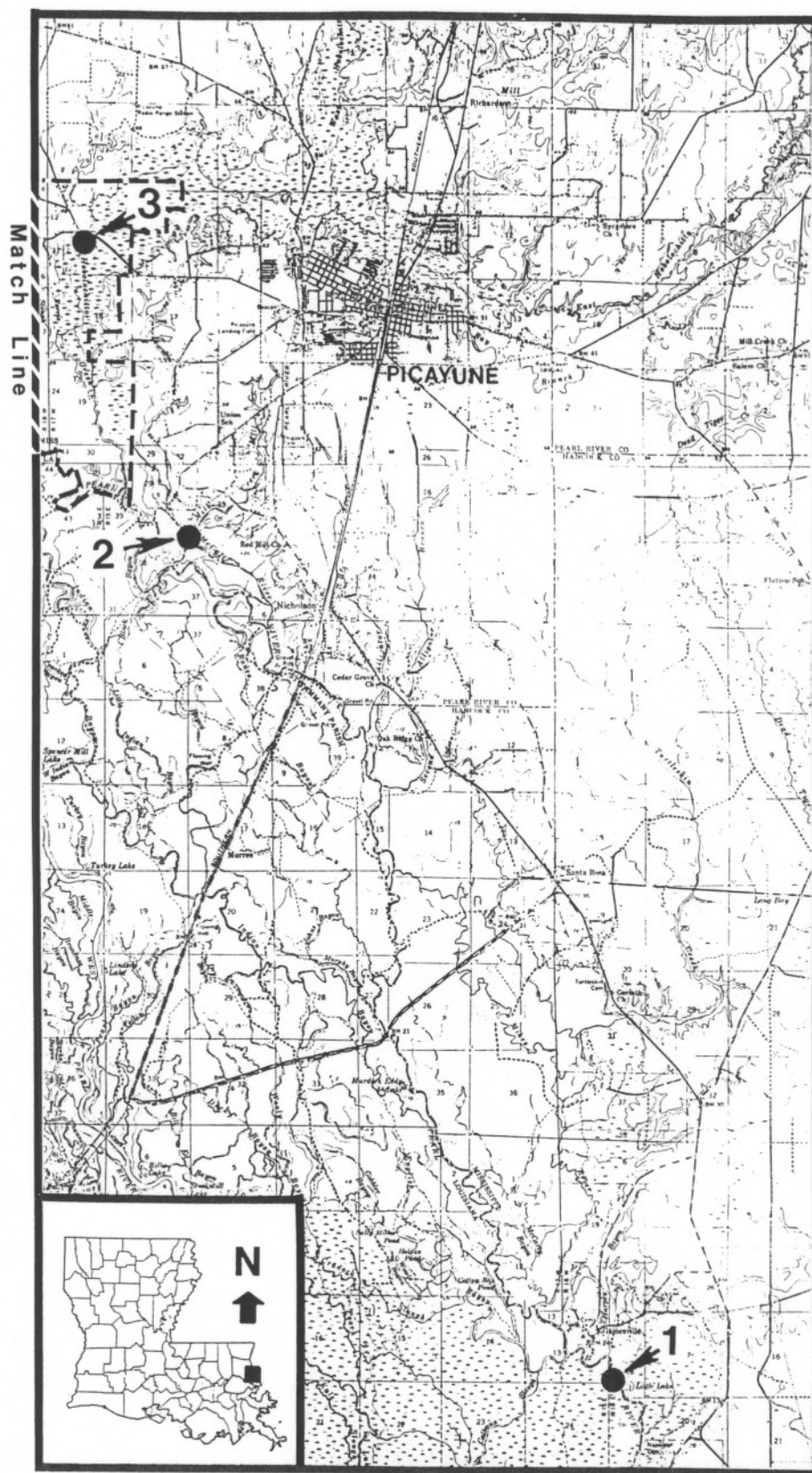


Figure 1. Southern Collection Stations for the Bogue Chitto NWR Contaminants Survey, 1991.

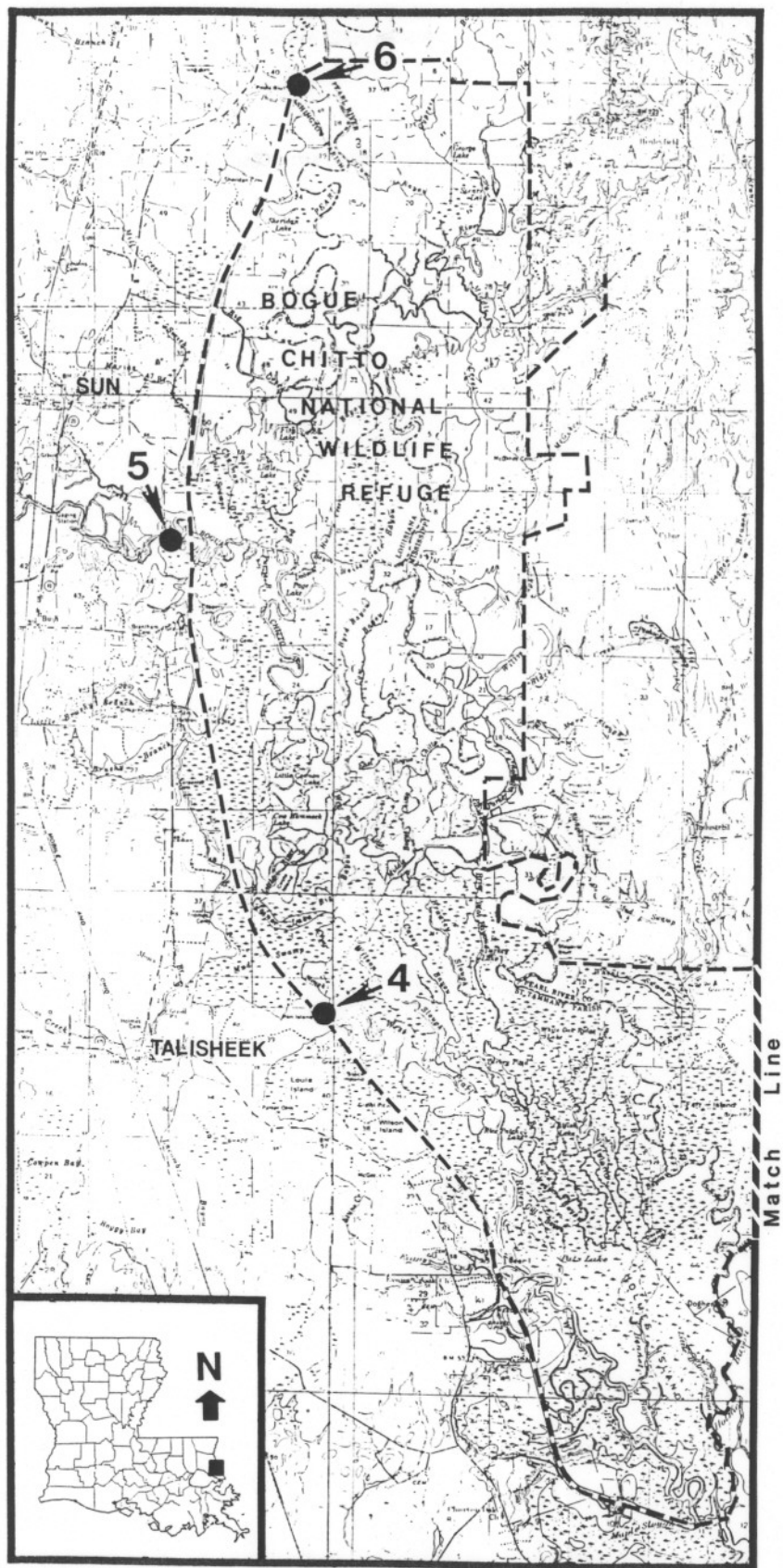


Figure 2. Northern Collection Stations for the Bogue Chitto NWR Contaminants Survey 1991.

Appendix Table A1 contains the minimum detectable levels for the various analyses performed and Tables A2 and A3 display the weights and percent moisture for the sediment and fish samples, respectively. The geometric means were determined using 75 percent of a given parameter's detection limit where sample concentrations were less than the detection limit.

RESULTS AND DISCUSSION

The analytical results for the Bogue Chitto NWR contaminants survey are presented in Tables 2 through 7. Tables 2 through 4 contain the results of the sediment analyses and tables 5 through 7 contain the results of the fish samples analyzed. Appendix Table B-1 presents a complete listing of fishes sampled by station, along with their weights and lengths.

Sediments

The sediment samples were analyzed for the residues of 20 organochlorine pesticides, 13 APHs (Table 2), 15 PAHs (Table 3), and 18 heavy metals (Table 4).

Organochlorines - The sediments of the NWR were remarkable in that they were virtually free of all organochlorines analyzed. All samples were below the detection limit with the lone exception of the Mills Creek (Station 2) sediment sample, which had p,p'-DDE at 0.02 mg/kg (i.e., the detection limit for this parameter).

Aliphatic Hydrocarbons - The APHs were represented in all sediments by at least two parameters, η -nonadecane and η -eicosane. The APHs present in the highest concentrations were η -heptadecane (0.21 mg/kg) and η -nonadecane (0.16 mg/kg) at the NASA Access Channel (Station 1). For all sediments combined, these also had the highest average concentration (0.05 mg/kg). The sediment at the NASA Access Channel (Station 1) was the most contaminated (0.80 mg/kg), with Mills Creek (Station 2) a close second (0.52 mg/kg). Overall, the APH levels in the Bogue Chitto National Wildlife Refuge sediments were well below levels observed in samples from other areas of Louisiana, i.e., Bayou Sauvage NWR (Schultz and Schultz 1988) and Sabine NWR (Schultz 1991).

Polynuclear Aromatic Hydrocarbons - PAHs were present in sediments at all locations, and were represented by at least benzo(b)fluoranthrene and benzo(e)pyrene, except at Station 5. The PAH present in the highest concentration was fluoranthrene (0.49 mg/kg) at Mills Creek (Station 2) and the highest average concentration for all sediments combined was fluoranthrene (0.06 mg/kg). The sediment total PAHs (TPAH) at Mills Creek (Station 2) was the highest (2.18 mg/kg). TPAH levels (1.79 and 0.82 mg/kg) at the NASA Access Channel and Talisheek Creek (Stations 1 and 4) were also elevated in comparison to the other stations. However, the PAH levels in the NWR sediments were well within acceptable guidelines indicated by the National Oceanic and Atmospheric Administration (NOAA 1988 and 1990) and the U.S. Environmental Protection Agency (EPA, Bolton et al. 1985).

Table 2. APH residues (mg/kg, dry weight) in sediments collected from the Bogue Chitto NWR and adjacent waters in July 1991

PARAMETER	STATIONS						Geometric Mean*	Standard Error
	1	2	3	4	5	6		
η -Dodecane	BDL	BDL	BDL	BDL	BDL	BDL	---	---
η -Tridecane	BDL	0.02	BDL	BDL	BDL	BDL	0.01	1.14
η -Tetradecane	BDL	0.02	BDL	BDL	BDL	BDL	0.01	1.14
Octylcyclohexane	BDL	0.02	BDL	BDL	BDL	BDL	0.01	1.14
η -Pentadecane	0.08	0.05	0.01	BDL	0.01	0.03	0.03	1.41
Nonylcyclohexane	BDL	0.02	0.01	BDL	BDL	BDL	0.01	1.14
η -Hexadecane	0.03	0.02	BDL	BDL	0.01	0.01	0.01	1.16
η -Heptadecane	0.21	0.07	0.03	BDL	0.04	0.08	0.05	1.55
Pristane	0.08	0.12	0.01	BDL	BDL	0.03	0.03	1.56
η -Octadecane	0.05	0.03	0.01	BDL	0.01	0.03	0.02	1.32
Phytane	0.11	0.10	0.04	BDL	0.01	0.04	0.04	1.51
η -Nonadecane	0.16	0.05	0.12	0.01	0.04	0.04	0.05	1.45
η -Eicosane	0.08	0.03	0.03	0.01	0.03	0.03	0.03	1.28
Total APH	0.80	0.52	0.26	0.02	0.17	0.29	0.23	1.64

BDL = Below detection limit.

- * The geometric means were determined using 75 percent of a given parameter's detection limit, where sample concentrations were less than the detection limit. Standard errors are a multiple or division of the geometric mean, rather than plus or minus.

Table 3. PAH residues (mg/kg, dry weight) in sediments collected from the Bogue Chitto NWR and adjacent waters in July 1991

PARAMETER	STATIONS						Geometric Mean**	Standard Error
	1	2	3	4	5	6		
Napthalene	BLD	BDL	BDL	BDL	BDL	BDL	---	---
Fluorene	BDL	0.03	BDL	BDL	BDL	BDL	0.01	1.24
Phenanthrene	BDL	0.13	BDL	0.07	BDL	BDL	0.02	1.53
Anthracene	BDL	0.05	BDL	BDL	BDL	BDL	0.04	1.32
Fluoranthrene	0.29	0.49*	BDL	0.21	BDL	0.01	0.06	2.13
Pyrene	0.24	0.40*	BDL	0.15	BDL	BDL	0.05	2.06
1,2-benzanthranene	0.13	0.16*	BDL	0.02	BDL	BDL	0.03	1.72
Chrysene	0.19	0.21*	BDL	0.07	BDL	0.01	0.04	1.81
Benzo(b)fluoranthrene	0.11	0.15	0.01	0.04	BDL	0.01	0.03	1.59
Benzo(k)fluoranthrene	0.05	0.03	BDL	0.01	BDL	BDL	0.02	1.35
Benzo(e)pyrene	0.13	0.33*	0.01	0.04	BDL	0.01	0.04	1.78
Benzo(a)pyrene	0.13	0.08	BDL	0.01	BDL	BDL	0.02	1.64
1,2,5,6-diben zanthrancene	0.08	0.02	BDL	0.04	BDL	BDL	0.02	1.43
Benzo(g,h,i) perylene	0.43	0.10	BDL	0.20	BDL	BDL	0.04	2.01
Total PAHs	1.79	2.18	0.03	0.82	BDL	0.06	0.19	2.57

BDL = Below detection limit

* Confirmed by GC/Mass Spectrometry

** The geometric means were determined using 75 percent of a given parameter's detection limit, where sample concentrations were less than the detection limit. Standard errors are a multiple or division of the geometric mean, rather than plus or minus.

Table 4. Heavy metal residues (mg/kg, dry weight) in sediments collected from the Bogue Chitto NWR and adjacent waters in July 1991

PARAMETER	STATIONS						Geometric Mean*	Standard Error
	1	2	3	4	5	6		
Aluminum	13100	4240	2910	340	4760	5000	3307	1.60
Barium	101	47.1	19.9	8.6	64.0	64.6	38.7	1.45
Beryllium	0.79	0.32	0.1	BDL	0.35	0.42	0.38	1.36
Boron	2.0	BDL	BDL	BDL	BDL	BDL	1.6	1.05
Cadmium	BDL	BDL	BDL	BDL	BDL	BDL	---	---
Chromium	13.0	5.3	3.0	BDL	5.5	6.3	4.2	1.48
Copper	7.4	2.9	1.0	0.6	2.8	3.8	2.7	1.45
Iron	11900	3670	1360	366	4780	5510	2882	1.70
Lead	14.0	7.0	BDL	BDL	7.0	7.0	5.9	1.27
Magnesium	957	238	160	13.0	345	465	206	1.83
Manganese	286	103.0	57.7	1.3	274	384	78.4	2.40
Molybdenum	BDL	BDL	BDL	BDL	BDL	BDL	---	---
Nickel	7.0	3.0	BDL	BDL	4.0	4.0	3.0	1.28
Selenium	0.4	0.3	BDL	BDL	BDL	BDL	0.20	1.20
Strontium	15.6	5.5	3.2	0.96	6.7	10.1	5.11	1.49
Vanadium	16.0	7.0	3.8	0.9	7.8	8.9	5.5	1.50
Zinc	41.5	16.0	6.6	0.5	14.0	18.0	9.1	1.87
Arsenic	1.7	0.76	0.3	0.2	1.1	1.6	0.72	1.44
Mercury	0.069	0.032	0.010	0.009	0.027	0.027	0.023	1.37

BDL= Below detection limit.

- * The geometric means were determined using 75 percent of a given parameter's detection limit, where sample concentrations were less than the detection limit. Standard errors are a multiple or division of the geometric mean, rather than plus or minus.

Table 5. Organochlorine residues (mg/kg, wet weight) in fish tissue samples collected from the Bogue Chitto NWR and adjacent waters in July 1991

PARAMETER/CONTAMINANT							
STATION	SPECIES	HEPT. EPOX.	γ -NONACHLOR	TOTAL PCB'S	α -CHLOR	p,p'-DDE	DIELDRIN
1	River redhorse	BDL	BDL	BDL	BDL	0.01	BDL
	Largemouth bass	BDL	0.01	0.13	BDL	0.01	BDL
	Largemouth bass	BDL	0.01	0.42	BDL	0.02	BDL
	Largemouth bass	BDL	BDL	0.24	BDL	0.01	BDL
2	Largemouth bass	BDL	BDL	BDL	BDL	0.10	BDL
	Largemouth bass	BDL	0.02	BDL	BDL	0.02	0.01
	Largemouth bass	BDL	0.01	BDL	BDL	0.02	0.01
4	Spotted sucker	BDL	BDL	BDL	BDL	BDL	BDL
	Chain pickerel	BDL	BDL	BDL	BDL	0.01	BDL
	Chain pickerel	BDL	BDL	BDL	BDL	0.01	BDL
	Chain pickerel	0.03	BDL	BDL	BDL	0.01	BDL
5	Spotted sucker	BDL	BDL	BDL	BDL	0.01	BDL
	Spotted bass	BDL	BDL	BDL	BDL	BDL	BDL
	Spotted bass	BDL	BDL	BDL	BDL	0.01	BDL
	Spotted bass	BDL	BDL	BDL	BDL	BDL	BDL
6	Largemouth bass	0.01	0.02	0.34	0.01	0.05	0.01
	Largemouth bass	0.01	0.01	0.25	0.01	0.03	BDL
	Largemouth bass	BDL	0.01	0.22	0.01	0.07	BDL

Table 6. APH residues (mg/kg, wet weight) in fish tissue samples collected from the Bogue Chitto NWR and adjacent waters in July 1991

STATION	SPECIES	WT. (g)	PARAMETER/CONTAMINANT						
			%H ₂ O	%LIPID	η-DO DECANE	η-TRI DECANE	η-TETRA DECANE	OCTYL CYC LOHEXANE	η-PENTA DECANE
1	River redhorse	93.9	70.8	3.48	0.03	0.03	0.02	BDL	0.08
	Largemouth bass	1060	73.4	4.52	0.04	0.05	BDL	0.01	0.06
	Largemouth bass	306	77.8	2.62	0.05	0.05	0.04	BDL	0.07
	Largemouth bass	690	74.0	5.81	0.03	0.04	BDL	BDL	0.07
2	Largemouth bass	140	74.8	3.95	0.03	0.04	0.02	BDL	0.08
	Largemouth bass	300	73.0	6.09	0.03	0.04	0.02	BDL	0.09
	Largemouth bass	355	73.6	5.76	0.03	0.04	0.02	0.02	0.10
4	Spotted sucker	492	74.8	5.00	0.03	0.03	0.02	BDL	0.10
	Chain pickerel	109	71.6	2.06	0.02	0.02	0.02	BDL	0.09
	Chain pickerel	174	73.6	1.76	0.02	0.03	0.02	BDL	0.10
	Chain pickerel	104	76.0	1.08	0.04	0.05	0.03	BDL	0.12
5	Spotted sucker	445	71.0	9.13	0.05	0.04	0.06	0.02	0.18
	Spotted bass	40.3	74.0	2.97	0.02	0.02	0.02	BDL	0.11
	Spotted bass	57.2	74.5	2.94	0.02	0.01	0.03	BDL	0.05
	Spotted bass	41.7	71.5	1.72	0.02	0.01	0.02	BDL	0.02
6	Largemouth bass	1880	72.8	5.38	0.04	0.05	0.03	BDL	0.16
	Largemouth bass	467	71.6	6.59	0.04	0.04	0.03	0.01	0.15
	Largemouth bass	608	70.8	7.71	0.04	0.04	0.03	BDL	0.16
	Geometric Mean*	-	-	-	0.03	0.03	0.02	0.09	0.09
	Standard Error	-	-	-	1.08	1.13	1.12	1.08	1.13

BDL = Below detection limit.

- * The geometric means were determined using 75 percent of a given parameter's detection limit, where sample concentrations were less than the detection limit. Standard errors are a multiple or division of the geometric mean, rather than plus or minus.

Table 6. APH residues (mg/kg, wet weight) in fish tissue samples collected from the Bogue (Contd.) Chitto NWR and adjacent waters in July 1991

STATION	SPECIES	PARAMETER/CONTAMINANT								
		NONYLCYC LOHEXANE	η -HEXA DECANE	η -HEPTA DECANE	PRIS TANE	η -OCTA DECANE	PHY- TANE	η -NONA DECANE	η -EIC OSANE	TAPH
1	River redhorse	0.08	0.08	1.9	BDL	0.25	0.17	1.6	0.25	0.38
	Largemouth bass	BDL	0.03	0.12	BDL	0.02	0.03	0.01	0.01	4.41
	Largemouth bass	BDL	0.06	2.3	BDL	0.05	0.02	0.08	0.02	3.28
	Largemouth bass	BDL	0.04	0.83	BDL	0.04	0.03	0.08	0.02	1.17
2	Largemouth bass	BDL	0.04	0.46	BDL	0.05	0.02	0.21	0.02	0.98
	Largemouth bass	BDL	0.06	1.1	BDL	0.08	0.02	0.38	0.02	1.85
	Largemouth bass	BDL	0.04	0.70	BDL	0.05	0.01	0.24	0.02	1.27
4	Spotted sucker	BDL	0.14	3.6	BDL	0.37	0.06	1.3	0.32	5.93
	Chain pickerel	BDL	0.08	2.3	BDL	0.10	0.02	0.24	0.03	2.91
	Chain pickerel	BDL	0.11	2.9	BDL	0.13	0.02	0.20	0.02	3.55
	Chain pickerel	BDL	0.10	3.1	BDL	0.10	0.02	0.19	0.03	3.77
5	Spotted sucker	BDL	0.31	7.6	BDL	0.64	0.17	3.1	0.53	2.42
	Spotted bass	BDL	0.08	1.5	BDL	0.11	0.04	0.48	0.04	1.65
	Spotted bass	BDL	0.04	1.2	BDL	0.07	0.03	0.18	0.02	1.05
	Spotted bass	BDL	0.03	0.68	BDL	0.07	0.02	0.16	0.02	12.7
6	Largemouth bass	BDL	0.03	0.09	0.05	0.02	0.10	BDL	BDL	0.57
	Largemouth bass	0.01	0.03	0.49	BDL	0.04	0.07	0.08	0.01	1.01
	Largemouth bass	0.01	0.04	0.90	BDL	0.05	0.07	0.10	0.01	1.46
Geometric Mean*		0.01	0.06	1.08	0.01	0.08	0.04	0.18	0.03	1.94
Standard Error		1.14	1.16	1.31	1.11	1.24	1.21	1.43	1.33	1.23

BDL = Below detection limit.

- * The geometric means were determined using 75 percent of a given parameter's detection limit, where sample concentrations were less than the detection limit. Standard errors are a multiple or division of the geometric mean, rather than plus or minus.

Table 7. Heavy metal residues (mg/kg, wet weight) in fish tissue samples collected from the Bogue Chitto NWR and adjacent waters in July 1991

STATION	SPECIES	PARAMETER/CONTAMINANT						
		Al	Ba	Cr	Cu	Fe	Mg	Mn
1	River redhorse	49.0	8.80	0.3	0.88	34.4	619.0	36.3
	Largemouth bass	0.8	2.80	BDL	0.26	20.0	410.0	0.76
	Largemouth bass	3.1	0.81	BDL	0.29	11.0	306.0	0.38
	Largemouth bass	44.0	2.80	0.5	0.33	46.6	305.0	3.1
2	Largemouth bass	19.0	2.40	BDL	0.81	19.0	305.0	0.92
	Largemouth bass	1.0	1.70	BDL	0.25	20.0	290.0	0.62
	Largemouth bass	0.8	1.80	BDL	0.27	18.0	293.0	0.64
4	Spotted sucker	14.0	5.90	BDL	0.74	36.0	368.0	14.1
	Chain pickerel	0.9	12.5	BDL	0.19	9.6	734.0	18.6
	Chain pickerel	8.5	4.60	BDL	0.45	11.0	518.0	9.98
	Chain pickerel	1.0	6.20	BDL	0.36	5.6	446.0	13.1
5	Spotted sucker	25.0	5.60	BDL	1.1	39.8	342.0	38.3
	Spotted bass	4.4	6.40	8.8	0.36	47.2	486.0	5.0
	Spotted bass	4.2	6.70	0.3	0.23	11.0	467.0	7.4
	Spotted bass	2.0	8.00	BDL	0.18	8.0	450.0	3.8
6	Largemouth bass	9.5	5.40	BDL	0.56	27.0	389.0	3.1
	Largemouth bass	8.2	8.60	BDL	1.10	56.6	388.0	11.1
	Largemouth bass	2.0	2.10	BDL	0.29	17.0	359.0	1.2

Table 7. Heavy metal residues (mg/kg, wet weight) in fish tissue samples collected (Contd.) from the Bogue Chitto NWR and adjacent waters in July 1991

STATION	SPECIES	PARAMETER/CONTAMINANT						
		Ni	Sr	V	Zn	Hg	As	Se
1	River redhorse	BDL	63.4	0.2	25.3	0.12	BDL	0.34
	Largemouth bass	BDL	37.0	BDL	9.8	0.81	BDL	0.35
	Largemouth bass	BDL	13.2	BDL	9.60	0.45	0.1	0.31
	Largemouth bass	BDL	21.4	BDL	9.6	0.41	0.05	0.31
2	Largemouth bass	3.1	20.0	BDL	11.7	0.89	BDL	0.36
	Largemouth bass	BDL	18.3	BDL	10.3	0.38	BDL	0.38
	Largemouth bass	BDL	18.8	BDL	9.5	0.35	BDL	0.35
4	Spotted Sucker	BDL	28.9	BDL	13.0	0.208	BDL	0.79
	Chain pickerel	2.9	50.0	BDL	46.6	0.23	BDL	0.24
	Chain pickerel	BDL	18.6	BDL	49.4	0.37	BDL	0.37
	Chain pickerel	BDL	24.2	BDL	41.8	0.28	BDL	0.24
5	Spotted sucker	BDL	27.7	BDL	12.3	0.36	BDL	0.45
	Spotted bass	3.9	47.8	BDL	21.4	0.239	BDL	0.41
	Spotted bass	BDL	52.2	BDL	20.7	0.245	BDL	0.40
	Spotted bass	BDL	53.3	BDL	22.2	0.16	BDL	0.41
6	Largemouth bass	BDL	26.9	BDL	9.1	0.56	BDL	0.31
	Largemouth bass	BDL	26.6	BDL	10.5	0.31	BDL	0.31
	Largemouth bass	BDL	21.6	BDL	10.4	0.266	BDL	0.27

Inorganic Residues - Sediments were analyzed for 19 inorganic residues (Table 2). Two, cadmium and molybdenum, were non-detected. Of those metals that were present, all were either below detection limits or occurred at levels not warranting concern when compared to various published criteria and guidelines (Anon. 1977; Bolton et al. 1985; Hart et al. 1988; NOAA 1988 and 1990; Persaud et al. 1989; and Sullivan et al. 1985).

Fishes

Whole-body and composite fish tissue samples were analyzed for 22 organochlorine residues (Table 5), 13 APHs (Table 6), and 19 inorganics (Table 7). The fish tissue samples were not analyzed for PAHs.

Organochlorines - The following 16 organochlorines were non-detected in the tissue samples: hexachlorobenzene (HCB), α -benzene hexachloride (BHC), γ -BHC, β -BHC, δ -BHC, oxychlordane, γ -chlordane, toxaphene, o,p'-DDE, o,p'-DDD, endrin, cis-nonachlor, o,p'-DDT, p,p'-DDD, p,p'-DDT, and mirex.

Of the six organochlorines detected in fishes (heptachlor epoxide, τ -nonachlor, α -chlordane, p,p'-DDE, dieldrin, and PCBs), only p,p'-DDE was present at all stations sampled (Table 5). τ -nonachlor was present at three stations; dieldrin, heptachlor epoxide, and PCBs were detected at two stations; and α -chlordane was detected at one station. Most of the organochlorines detected were found in largemouth bass, which represented half of the samples analyzed.

The largemouth bass from the northernmost sampling location at Pools Bluff (Station 6) were the most contaminated, with six residues detected (i.e., heptachlor epoxide, τ -nonachlor, α -chlordane, p,p'-DDE, dieldrin, and PCBs). Three residues were detected at Station 1 (the NASA Access Channel): τ -nonachlor, p,p'-DDE, and PCBs and Station 2 (Mills Creek): τ -nonachlor, p,p'-DDE, and dieldrin. Heptachlor epoxide and p,p'-DDE were detected at Talisheek Creek (Station 4), and only p,p'-DDE was detected at the Bogue Chitto River (Station 5). The latter two stations were also the only sample sites not represented by analysis of largemouth bass.

For the most part, the organochlorine data were unremarkable. PCBs were detected only at the NASA Access Channel (Station 1) and Pools Bluff (Station 6) with one of the largemouth bass collected at the NASA Access Channel exceeding the National Contaminant Biomonitoring Program's (NCBP; Schmitt et al. 1990) average (0.39 mg/kg) for PCBs, with a concentration of 0.42 mg/kg.

Aliphatic Hydrocarbons - APHs (Table 6) were detected in tissues at all sites with the exception of octylcyclohexane, which was absent from Talisheek Creek (Station 4); nonylcyclohexane, which was absent from Mills Creek (Station 7); Talisheek Creek (Station 4), and Bogue Chitto River (Station 5); and pristane, which was present only at Pools Bluff (Station 6). Thus, all analytes were present only at Pools Bluff (Station 6).

The suckers (spotted sucker and river redhorse) were by far the most contaminated fishes analyzed; the Talisheek Creek (Station 4) spotted sucker composite sample had a TAPH concentration of 5.93 mg/kg and the Bogue Chitto River (Station 5) spotted sucker composite sample had over twice that amount (12.70 mg/kg). The latter sample contained both the highest concentrations for 9 out of the 13 APHs analyzed, and the highest lipid content of all fishes analyzed. The river redhorse ranked third in TAPHs (4.41 mg/kg).

The river redhorse feeds on molluscs, for which it is especially adapted, and on aquatic insects (Lee et al. 1980). Molluscs tend to be very efficient bioconcentrators of contaminants, which offers a possible explanation for the elevated TAPH levels.

The highest average concentration (0.34 mg/kg) for TAPHs was found in the Bogue Chitto River sample (Station 5), Talisheek Creek (Station 4) ranked second with 0.31 mg/kg, and the NASA Access Channel (Station 1) was third at 0.17 mg/kg. However, these data appear to be skewed by the APHs in the three suckers. If the APH data for suckers are ignored, the mean TAPH for the Bogue Chitto River (Station 5) drops from 0.34 mg/kg to 0.14 mg/kg i.e., from (first to second), moving Talisheek Creek (from 0.31 to 0.28 mg/kg) to the highest in TAPH contamination. The NASA access channel remains in the third position (0.17 to 0.12 mg/kg).

In comparing the APH tissue data with that of the APH sediment data, the station with the highest tissue APHs had the lowest sediment APHs, while the station with the highest sediment APHs ranked fourth in tissue APHs. In general, the TAPH tissue data exceeded similar data collected from other areas in Louisiana (Schultz and Schultz 1988, Bayou Sauvage National Wildlife Refuge; Schultz 1991, Sabine National Wildlife Refuge; and Conzelmann and Schultz 1992, Caernarvon Freshwater Diversion Project).

Heavy Metals - Five heavy metals (beryllium, boron, cadmium, lead, and molybdenum; Table 8) were non-detected in tissue samples. Chromium was detected in the river redhorse and largemouth bass at the NASA Access Channel (Station 1) and in two spotted bass from the Bogue Chitto River (Station 5). Nickel was detected in a largemouth bass at Mills Creek (Station 2), a chain pickerel at Talisheek Creek (Station 4), and a spotted bass at Bogue Chitto River (Station 5). Vanadium was detected in the river redhorse only, and arsenic was found in two largemouth bass from the NASA Access Channel (Station 1). None of the above heavy metals, however, were detected at levels warranting concern.

All other elemental analytes were detected at all stations and in all fishes sampled, with most at levels considered unremarkable. Copper, however, exceeded the NCBP (Schmitt and Brumbaugh 1990) mean concentration of 0.65 mg/kg in one fish at each station, and exceeded the NCBP's 85th percentile of 1.0 mg/kg in the spotted sucker composite sample from the Bogue Chitto River (Station 5) and in a largemouth bass from Pools Bluff (Station 6). Zinc exceeded the NCBP's mean concentration of 21.7 mg/kg in the river

redhorse from the NASA Access Channel (Station 1) and in a spotted bass from the Bogue Chitto River (Station 5), and exceeded the NCBP's 85th percentile of 34.2 mg/kg in the three chain pickerel from Talisheek Creek. Selenium levels in spotted suckers exceeded the NCBP's mean concentration of 0.42 mg/kg at the Bogue Chitto River station and the NCBP's 85th percentile of 0.73 mg/kg at Talisheek Creek. The elevated mercury tissue levels were more pronounced, however, thus warranting special concern.

At comparatively low concentrations, mercury can adversely affect the reproduction, growth, behavior, metabolism, blood chemistry, osmoregulation, and oxygen exchange of freshwater organisms (Eisler, 1987). Bioconcentration factors¹ (BCF) in whole body rainbow trout immersed in a 0.1 µg Hg/L solution ranged from 7,000 (for the inorganic mercuric ion) to 36,000 (for methylmercury). Methylmercury, when consumed at levels as low as 0.1 mg/kg, wet weight, may adversely affect reproduction in sensitive species of birds (Hienz 1979, Eisler 1987).

Mercury levels in tissue of all Bogue Chitto NWR fishes exceeded the NCBP's mean concentration of 0.10 mg/kg and all exceeded the NCBP's 85th percentile of 0.17 mg/kg except for the river redhorse from the NASA Access Channel (Station 1) and a spotted bass from the Bogue Chitto River (Station 5). Also, the NCBP's maximum concentration of 0.37 mg/kg was equaled by a chain pickerel from Talisheek Creek (Station 4) and exceeded by several largemouth bass, three from the NASA Access Channel (Station 1), two from Mills Creek (Station 2), and one from Pools Bluff (Station 6).

The above values, particularly those for methylmercury, could adversely affect reproduction in sensitive species of birds. For human consumption, these values are not directly comparable to the FDA action level of 1 ppm mercury, in that they are for whole fishes and not the edible portion. Whole body concentrations have generally been considered to be two to three times greater than that of the edible portion. Thus these mercury concentrations would normally have been considered safe for human consumption. However, Douglas (1992) has shown that mercury levels in fishes from the Tombigbee River, Alabama, were higher in filets than in the carcasses. In Douglas (1992), the relative percent concentration of mercury in 13 of the 15 fish filets analyzed exceeded that of the carcass, i.e., over 50 percent of mercury detected in the edible portion, with one filet exceeding 75 percent. Thus, although no comparative analyses were performed, there is the potential for the filets of some of the Bogue Chitto fish samples to exceed the FDA action level.

¹The ratio between the concentrations of a contaminant in fish tissue and the water concentration.

CONCLUSIONS

This investigation of the Bogue Chitto River watershed constitutes the first assessment by the Fish and Wildlife Service of contamination levels in and around the Bogue Chitto NWR. The present study revealed three areas of concern for fishes: elevated levels of PCBs at the NASA Access Channel and Pools Bluff; elevated levels of TAPHs, especially in suckers; and elevated inorganic residues, especially mercury. The sediment analyses did not reveal areas of immediate potential concern. Future surveys will be conducted, pending approval and available funding, to assess contaminant trends, ascertain sources of pollutants, and recommend measures to reduce or eliminate contaminant inputs.

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APPENDIX A

ANALYTICAL METHODOLOGIES

I. Methodology for analyses of organochlorine pesticides and PCBs in animal tissues.

A 10 g tissue sample was thoroughly mixed with anhydrous sodium sulfate and soxhlet extracted with hexane for 7 hours. The extract was concentrated by rotary evaporation, transferred to a tared test tube, and further concentrated to dryness for lipid determination. The weighed lipid sample was dissolved in petroleum ether and extracted four times with acetonitrile saturated with petroleum ether. Residues were partitioned into petroleum ether which was washed, concentrated, and transferred to a glass chromatographic column containing 20 g of Florisil. The column was eluted with 200 mL 6% diethyl ether/94% petroleum ether (Fraction I) followed by 200 mL 15% diethyl ether/85% petroleum ether (Fraction II). Fraction II was concentrated to appropriate volume for quantification of residues by packed or capillary column electron capture gas chromatography. Fraction I was concentrated and transferred to a silicic acid chromatographic column for additional cleanup required for separation of PCBs from other organochlorines. Three fractions were eluted from the silicic acid column. Each was concentrated to appropriate volume for quantification of residues by packed or megabore column, electron capture gas chromatography. PCBs were found in Fraction II.

II. Methodology for analyses of organochlorine pesticides and PCB's in sediment

A 25 g sediment sample was extracted with acetone followed by hexane, by allowing to soak 1 hour in each with intermittent shaking. The combined extracts were centrifuged and decanted into a separatory funnel containing sufficient water to facilitate partitioning of residues into the hexane portion. The hexane was washed twice with water and concentrated to appropriate volume for transfer to a 1.6 g Florisil mini-column topped with 1.6 g sodium sulfate. Residues were eluted from the column in two elution fractions. Fraction I consists of 12 mL of 1% methanol in hexane followed by 12 mL of 1% methanol in hexane, and Fraction II consists of an additional 24 mL of 1% methanol in hexane. If additional cleanup was required to separate PCBs from other organochlorines in Fraction I, further chromatography on a Silicic acid column was performed. Quantification of residues in the two Florisil fractions and three Silicic acid fractions was by packed or megabore column, electron capture gas chromatography.

III. Methodology for analyses of APHs and PAHs in animal tissues

A sample of appropriate size (i.e. 15 g animal tissue, 2 g adipose, etc.) was digested in 6N aqueous potassium hydroxide for 24 hours at 35°C. The digestate was cooled thoroughly in an ice bath and carefully neutralized with glacial acetic acid. The neutralized reaction mixture was extracted 3 times with methylene chloride; the combined extracts were concentrated to near-dryness and reconstituted in petroleum ether for transfer to a 20 g 1% deactivated silica gel column, topped with 5 g neutral alumina. APH and PAH residues were separated by eluting aliphatics from

the column with 100 mL petroleum ether (Fraction I) followed by elution of aromatics using first, 100 mL 40% methylene chloride/60% petroleum ether, then 50 mL methylene chloride (Combined eluates, Fraction II). If needed, Fraction I containing aliphatics was subjected to additional cleanup by concentration and transferred to a deactivated (2% water) Florisil column. APH residues were eluted from the Florisil column using 200 mL 6% diethyl ether/94% petroleum ether. The eluate was concentrated to appropriate volume for quantification by capillary column, flame ionization gas chromatography.

IV. Methodology for analyses of APHs and PAHs in sediment

A 20 g sediment sample was extracted with acetone, followed by petroleum ether, by allowing to soak one hour in each with intermittent shaking. A final acetone/petroleum ether extraction was done, and the extracts were combined, centrifuged, and transferred to a separatory funnel containing sufficient water to facilitate partitioning of residues into a petroleum ether portion. The petroleum ether was washed twice with water and concentrated by Kuderna-Danish to appropriate volume for transfer to a 20 g 1% deactivated silica gel column, topped with 5 g neutral alumina. APHs and PAHs residues were fractionated by eluting APHs from the column with 100 mL petroleum ether (Fraction I) followed by elution of PAHs using first, 100 mL 40% methylene chloride/60% petroleum ether, then 50 mL methylene chloride (Combined eluates, Fraction II). If needed Fraction I containing APHs was subjected to additional cleanup by concentration and transferred to a deactivated (2% water) Florisil column. APH residues were eluted from the Florisil column using 200 mL 6% diethyl ether/94% petroleum ether. The eluate was concentrated to appropriate volume for quantification by capillary column, flame ionization gas chromatography. The silica gel Fraction II containing aromatic hydrocarbons was concentrated, reconstituted in methylene chloride, and subjected to a gel permeation chromatography (GPC) cleanup prior to quantification by capillary flame ionization gas chromatography and fluorescence HPLC.

V. Elution profiles for Florisil, silica gel, and silicic acid column separations

A. Florisil Column:

1. Fraction I (6% ethyl ether containing 2% ethanol, 94% petroleum ether)
HCB, α -BHC, β -BHC, γ -BHC, δ -BHC, oxychlordane, heptachlor epoxide, γ -chlordane, τ -nonachlor, toxaphene, PCBs, o,p'-DDE, α -chlordane, p,p'-DDE, o,p'-DDD, cis-nonachlor, o,p'-DDT, p,p'-DDD, p,p'-DDT, and mirex.
2. Fraction II (15% ethyl ether containing 2% ethanol, 85% petroleum ether) Dieldrin and endrin.

B. Florisil Mini-Column:

1. Fraction I (12 mL hexane followed by 12 mL 1% methanol in hexane) HCB, α -BHC (splits with Fraction II), γ -BHC (25%),

τ -nonachlor, o,p'-DDE, p,p'-DDE, o,p'-DDD, o,p'-DDT, p,p'-DDD (splits with Fraction II), p,p'-DDT, mirex, cis-nonachlor, and PCBs.

2. Fraction II (24 mL 1% methanol in hexane)
 α -BHC (splits with Fraction I), β -BHC, γ -BHC (75%), δ -BHC, oxychlordane, heptachlor epoxide, and toxaphene.

C. Silica Gel:

1. SG Fraction I (100 mL petroleum ether) η -dodecane, η -tridecane, η -tetradecane, octylcyclohexane, η -pentadecane, nonylcyclohexane, η -hexadecane, η -heptadecane, pristane, η -octadecane, phytane, η -nonadecane, and η -eicosane.

2. SG Fraction II (100 mL 40% methylene chloride in petroleum ether followed by 50 mL methylene chloride) naphthalene, fluorene, phenanthrene, anthracene, fluoranthrene, pyrene, 1,2-benzanthracene, chrysene, benzo(b)fluoranthrene, benzo(k)fluoranthrene, benzo(e)pyrene, benzo(a)pyrene, 1,2,5,6-dibenzanthracene, and benzo(g,h,i)perylene.

D. Silicic Acid:

1. SA Fraction I (20 mL petroleum ether)
HCB and mirex.

2. SA Fraction II (100 mL petroleum ether)
PCBs and p,p'-DDE (splits with SA Fraction III)

3. SA Fraction III (20 mL mixed solvent: 1% acetonitrile, 80% methylene chloride, and 19% hexane)
 α -BHC, β -BHC, γ -BHC, δ -BHC, oxychlordane, heptachlor epoxide, γ -chlordane, toxaphene, o,p'-DDE, α -chlordane, p,p'-DDE, o,p'-DDD, cis-nonachlor, o,p'-DDT, p,p'-DDD, and p,p'-DDT.

VI. Methodology for analyses of inorganics in animal tissues

A. Tissue sample preparation

1. Homogenization These were performed using a Kitchen Aid food processor. Portions were then freeze dried for determination of moisture content and subsequent acid digestion.

2. Preconcentration Digestion for Inductively Coupled Plasma Emission (ICP) Measurements Using a CEM microwave oven, 0.5 g of freeze dried tissue was heated in a capped 120 mL Teflon vessel in the presence of 5 mL of Baker Instra-Analyzed HNO₃ for three minutes at 120 watts, three minutes at 300 watts, and 35 minutes at 450 watts. The vessel contents were then allowed to cool and the cap was removed and rinsed carefully with 3 mL of HNO₃ adding the rinsing with the vessel's contents. The uncapped vessel was then returned to the microwave oven and heated until the vessel contents were less than 1 mL in volume. The contents were carefully rinsed with laboratory pure water into a 10 mL glass volumetric vessel and made to volume with additional laboratory pure water.

The flask contents were then immediately transferred to a clean plastic centrifuge or auto sampler tube and centrifuged for 1 minute to precipitate the suspended matter. The sample was now ready for ICP analysis.

3. Digestion for ICP Measurement Using a CEM microwave oven, 0.25 to 0.5 g of freeze dried tissue was heated in a capped 120 mL Teflon vessel in the presence of 5 mL of Baker Instra-Analyzed HNO_3 for three minutes at 120 watts, three minutes at 300 watts, and 15 minutes at 450 watts. The residue was then diluted to 50 mL with 5% HCl.

4. Digestion for Graphite Furnace Atomic Absorption (GFAA) Measurement Using a CEM microwave oven, 0.25 to 0.5 g of freeze dried tissue was heated in a capped 120 mL Teflon vessel in the presence of 5 mL of Baker Instra-Analyzed HNO_3 for three minutes at 120 watts, three minutes at 300 watts, and 15 minutes at 450 watts. The residue was then diluted to 50 mL with laboratory pure water.

5. Digestion for Mercury Measurement by Cold Vapor Atomic Absorption (CVAA) A 0.25 to 0.5 g aliquot of tissue was refluxed for 2 hours in 10 mL Baker Instra-Analyzed HNO_3 and diluted to 50 mL with 1% HCl.

B. MEASUREMENT

1. ICP ICP measurements were made using a Leeman Labs Plasma Spec I sequential spectrometer.

2. GFAA GFAA measurements were made using a Perkin Elmer Zeeman 3030 atomic absorption spectrophotometer with an HGA-600 graphite furnace and an AS-60 autosampler.

3. CVAA Mercury measurements were conducted using SnCl_4 as the reducing agent. An Instrumentation Laboratories Model 251 AA spectrophotometer was employed.

VII. Methodology for analyses of inorganics in sediment

A. Sediment sample preparation

1. Homogenization This was performed by freeze drying a sample and then grinding it to approximately 100 mesh using a glass mortar and pestle.

2. Digestion for Inductively Coupled Plasma Emission (ICP) Measurements A 0.25 to 0.5 g aliquot of sediment was placed in a 120 mL Teflon microwave vessel. One mL each of HCl, HF, and HClO_4 and 10 mL HNO_3 were added to the vessel. The vessel was then capped according to manufacturer's instruction and was heated in a CEM microwave oven for 2 minutes at 120 watts, 3 minutes at 180 watts, and 10 minutes at 600 watts. The resulting residue was then diluted to 100 mL with 5% HCl. This solution was then filtered through Whatman 41 filter paper prior to ICP measurement. An HF resistance torch tip was used for these digests during the ICP measurements.

3. Digestion for Graphite Furnace Atomic Absorption (GFAA) Measurement Using a CEM microwave oven, 0.25 to 0.5 g of freeze dried sediment was heated in a capped 120 mL Teflon vessel in the presence of 5 mL of HNO_3 (Baker Instra-Analyzed) for 3 minutes at 120 watts, 3 minutes at 300 watts, and 15 minutes at 450 watts. The residue was then diluted to 50 mL with laboratory pure water.

4. Digestion for Mercury Measurement by Cold Vapor Atomic Absorption (CVAA) A 0.25 to 0.5 g aliquot of sediment was refluxed for 2 hours in 10 mL Baker Instra-Analyzed HNO_3 and diluted to 50 mL with 1% HCl .

B. MEASUREMENT

1. ICP ICP measurements were made using a Leeman Labs Plasma Spec I sequential spectrometer.

2. GFAA GFAA measurements were made using a Perkin Elmer Zeeman 3030 atomic absorption spectrophotometer with an HGA-600 graphite furnace and an AS-60 autosampler.

3. CVAA Mercury measurements were conducted using SnCl_4 as the reducing agent. An Instrumentation Laboratories Model 251 AA spectrophotometer was employed.

Table A-1. Minimum detection levels (MDL, mg/kg) for organochlorines, APHs, and PAHs on a wet weight basis and metals on a dry weight basis.

ORGANOCHLORINES (ww)			METALS (dw)		
PARAMETER	FISH	SEDIMENT	PARAMETER	FISH	SEDIMENT
HCB	0.01	0.01	Aluminum	3.0	4.0
α -BHC	0.01	0.01	Arsenic	0.2	0.2
γ -BHC	0.01	0.01	Barium	0.1	0.1
β -BHC	0.01	0.01	Beryllium	0.1	0.1
δ -BHC	0.01	0.01	Boron	2.0	2.0
Oxychlordane	0.01	0.01	Cadmium	0.3	0.3
Hept. Epox.	0.01	0.01	Chromium	1.0	1.0
γ -Chlordane	0.01	0.01	Copper	0.2	0.5
τ -Nonachlor	0.01	0.01	Iron	1.0	1.0
Toxaphene	0.05	0.05	Lead	4.0	4.0
PCBs (total)	0.05	0.05	Magnesium	4.0	0.2
o,p'-DDE	0.01	0.01	Manganese	0.2	0.2
Mirex	0.01	0.01	Mercury	0.08	0.008
α -Chlordane	0.01	0.01	Molybdenum	1.0	1.0
p,p'-DDE	0.01	0.01	Nickel	2.0	2.0
Dieldrin	0.01	0.01	Selenium	0.2	0.2
o,p'-DDD	0.01	0.01	Strontium	0.1	0.1
Endrin	0.01	0.01	Vanadium	0.4	0.8
cis-nonachlor	0.01	0.01	Zinc	0.2	0.3
o,p'-DDT	0.01	0.01			
p,p'-DDD	0.01	0.01			
p,p'-DDT	0.01	0.01			
All APHs (ww)	0.01	0.01	All PAHs (ww)	NA	0.01

NA - Not analyzed.

Table A-2. Sample weight and percent moisture in sediments collected from the Bogue Chitto NWR and adjacent waters in July 1991

STATIONS	1	2	3	4	5	6
Organics Analyses						
Weight (g)	725	542	839	766	574	725
Moisture (%)	62.6	39.2	24.0	18.2	30.0	28.8
Inorganic Analyses						
Weight (g)	120.1	119.4	184.0	147.0	158.5	157.7
Moisture(%)	56.5	44.8	26.8	18.6	28.5	29.5

Table A-3. Sample weights and percent moisture for fish samples collected from the Bogue Chitto NWR and adjacent waters in July 1991

STATION	SPECIES	WT. (g)	%LIPID	%H ₂ O ^a	%H ₂ O ^b
1	River redhorse	93.9	3.48	70.8	69.5
	Largemouth bass	1060	4.52	73.4	73.0
	Largemouth bass	306	2.62	77.8	76.1
	Largemouth bass	690	5.81	74.0	74.4
2	Largemouth bass	140	3.95	74.8	74.6
	Largemouth bass	300	6.09	73.0	73.2
	Largemouth bass	355	5.76	73.6	73.2
4	Spotted sucker	492	5.00	74.8	74.7
	Chain pickerel	109	2.06	71.6	69.1
	Chain pickerel	174	1.76	73.6	73.5
	Chain pickerel	104	1.08	76.0	74.5
5	Spotted sucker	445	9.13	71.0	70.3
	Spotted bass	40.3	2.97	74.0	72.4
	Spotted bass	57.2	2.94	74.5	73.5
	Spotted bass	41.7	1.72	71.5	72.5
6	Largemouth bass	1880	5.38	72.8	72.0
	Largemouth bass	467	6.59	71.6	71.7
	Largemouth bass	608	7.71	70.8	71.2

^aPercent moisture for organic analyses.

^bPercent moisture for inorganic analyses.

APPENDIX B

FISH WEIGHTS AND MEASUREMENTS

Table B-1. Summary of lengths and weights for the fish samples collected from the Bogue Chitto National Wildlife Refuge and adjacent waters in July 1991.

STATION	SPECIES	LENGTH (mm)	WEIGHT* (g)
1	LARGEMOUTH BASS	424	1060
		283	293
		355	698
2	RIVER REDHORSE	226	99
	LARGEMOUTH BASS	225	151
		281	309
		290	359
4	CHAIN PICKEREL	114	277
		174	326
		100	275
	SPOTTED SUCKER	544	371
		297	299
		92	205(933)
5	SPOTTED BASS	44	164
		61	178
		46	165
	SPOTTED SUCKER	498	353
		539	366
		290	296(1327)
6	LARGEMOUTH BASS	1996	493
		484	322
		626	345

* weights of composite samples shown in parentheses.

(35) Pgs
(35) BATCHES

DATE: _____

BATCH NAME: _____

RPT 00161

JOB OUTPUT TYPE: ASCII EBCDIC

5 1/4 3 1/2 9 TRACK

OUTPUT MEDIA: 5 1/4 3 1/2 9 TRACK

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